10/26/2006 LENA flight MCP's gain changes over time 1999-2006

Background notes on MCP Plateau Curves.
MCP HV power supply settings are usually determined by first obtaining a "plateau" curve. Here the MCP is stimulated by a source of constant intensity (electrons, energetic ions or photons) as the applied HV is swept over a predetermined range. The countrate is monitored and plotted as a function of this voltage.
If the MCP voltage is too low, then the pulse height distribution follows a negative exponential, and the actual recorded countrate will be very sensitive to the level set by the detection electronics, in addition to small changes in the HV level.
If the MCP voltage is at the correct level, all the o/p pulses from an MCP are counted, and increasing the HV does not result in an increase in the MCP countrate. When this happens the measured rate levels off even as the HV is increased, and so a "Plateau" it reached. Under ideal conditions we would operate the MCP HV PS at the point at which this plateau begins.
Also if the intensity of the beam is too great, for a particular MCP (compared to the strip or bias current), then again the pulse height distribution will follow a negative exponential, and the measured countrate will most likely not reach a plateau region, even with increasing HV applied.

In the case of LENA, the MCP HV level could be programmed in flight, as could the "Constant Fraction Discriminator", or CFD part of the detection electronics. This had 16 levels, 0 = High to 15 v. Low. (need to be careful not to set it too low, otherwise you will register cross-talk (small pulses from adjacent MCP's for example).

To obtain a plateau curve in flight, we plot the countrate associated with the 'Sun pulse' as a function of HV P/S setting. This was usually done for different CFD levels.

Note MCP data that comes from the "Sun" pulse, most likely come predominately from one facet. (If the sun pulse has just come into Lena's field of view then this would correspond to Facet # 1 or #4).

Note on conversion for Start MCP PS Setting
Control Voltage = 0-10, = 0-255 digital = 596 to 2985V actual MCP
1 count = ~9.3 volts

Note on conversion for Stop MCP PS Setting
Control Voltage = 0-10, = 0-255 digital = 565 to 2790V actual MCP
1 count = ~8.7 volts
(The Stop MCP P/S was also used to bias the C-Foil at ~-400V)

Plateau Curve Obtained in the Lab, 1/22/1999
The first set of plots was obtained in the lab on 1/22/1999, by firing a 10keV H2 ion beam at each MCP (or facet) in the TOF unit directly. In the lab we were able to look at the individual response of each MCP. This is in contrast to the flight situation, where all the counts from the four "Start" MCP's are summed, to give us the "Starts", likewise all the counts in the four stop MCP's are summed to give us the "Stops".

It is not clear why there is such a large offset in plateau curve data obtained during flight, as compared to those obtained in the lab. The flight DPU was not used in the lab, rather the data was obtained using standard laboratory instrumentation, and the MCP H/V P/S were controlled using analog o/p from the lab computer setup etc, so this may account for some of the differences, though we cannot be sure.

Plateau Curves obtained during flight
The first good Start MCP plateau curve was not obtained until 2003/02/04, so again we cannot be certain how the gain behavior changed before then. The offset from the lab data appears to be of order 40 counts (370 volts or so), after that till the last curve obtained on 2004/11 the gain changed by only 10 counts. My guess is that something may well have happened to the Start MCP's and/or Start MCP HV PS during the Collimator and A111 incident mentioned below.

The Stop MCP plateau curves were much less variable during the whole lifetime of LENA. This may be due in part to the fact that as they are physically larger, the counts/cm^2 is less, so they age more slowly.

Notes on the rates for MCP levels 144, 160 (16 count difference) during 2000/9/10.
From the 1999 lab data, taken with CFD level = 10, the rate increases by only ~40% over the above MCP HV range, as we are almost on the plateau.
Later e.g. 2003/03/04 for levels 168,184 (same 16 count difference) the change in count rates (209, 4560) is a factor ~ 20 or so. So depending on the condition of the plates in the 2000/10 2000/11 time frame, and where we were operating on the plateau curve at the time, it is not unreasonable to have a factor of 10 - 20 change in countrates for a change of 16 counts in the MCP HV level setting. Unfortunately we did not perform any in flight plateau curves to monitor MCP degradation during the first two years of operation, so we cannot be certain.

Optics H/V P/S setting.
This determines the energy of the ions as they pass through the carbon foil.
For nearly the whole of the mission, this was set at 120 digital = -11382V actual.
During 2000/7 and 2000/8 there was a period when this was 128 digital =-11962V actual.
A difference of ~600 v in the energy can have a very noticeable affect on the transmission of heavy ions through a carbon foil, particularly if they are as thick as ~2ug /cm^2 as was the case for LENA. Heavy ions scatter more, and there is more stragling in the foils, so detection efficiency is more dependant on ion energy and foil thickness, then is the case for H.

Status of the collimator.
Up until 2000/9/6 both the +ve and –ve collimator H/V P/S operated OK. On 2000/9/7 an incident occurred, which caused us to have trouble with both of them. Both were automatically turned off, so subsequently attempts made to turn them back on.

On 2000/9/18 that we were able to turn the collimator back on, and then only the –ve HV P/S at its lowest setting. It was not possible to turn the +ve HV PS on due to the current it wanted to draw. Most likely the insulators used to stand off voltages were shorted by metallic ions sputtered from the collimator plates.

Also it should be noted that one of the A111 preamps required to obtain the azimuthal resolution was also lost during the same event.

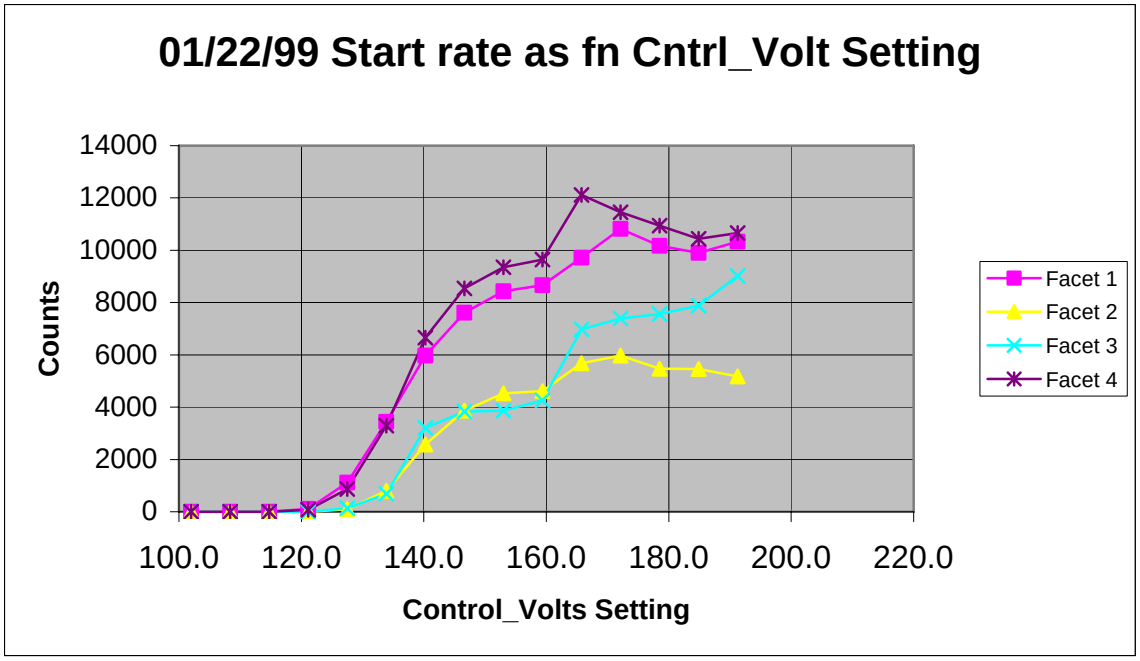
Note: During the period 2000/9/9 – 2000/9/18 both the Coll- and Coll+ HV PS were off. The result is that any +ve ions that can now pass through the aperture at the back of the collimator, were accelerated by the –ve potential (~12kV) on the conversion surface, and so could strike the surface at 12keV sputtering e.g. H, and O from the surface, which may then be detected.

Summary, year/date for in flight MCP Start and Stop Plateau Curves.

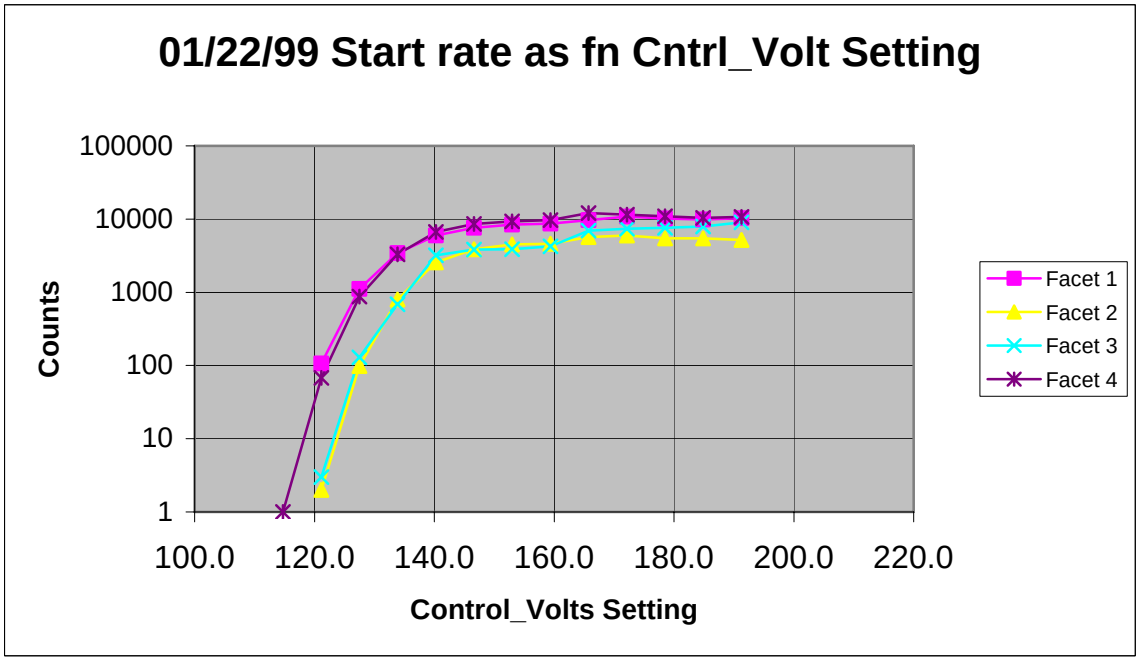
2002 02 20	Stop Scan	?			
2002 08 19	Start Scan	96-160	CFD Fixed	O.K.	
2002 08 20	Stop Scan	96-144	CFD Fixed	O.K.	
2003 02 04	Start Scan	96-190	CFD 6	O.K.	
2003 02 20	Stop Scan	140-165	CFD 6	O.K.	
2003 05 10	Start Scan	160-190	CFD 10,8,6	O.K.	
2003 05 11	Stop Scan	140-164	CFD 6,4,2	O.K.	
2003 09 08	Start Scan	160-190	CFD 10,8,12	(default 176, 10)	O.K.
2003 09 09	Stop Scan	140-164	CFD 6,4,8	(default 149,6)	O.K.
2003 11 23	Start CFD Scan 0 - 10		MCP=185 fixed	O.K.	
2003 11 24	Stop CFD Scan 0 - 15		MCP=149 fixed	O.K.	
2004 05 31	Start Scan	160-199	CFD 10,8,12	O.K.	
2004 05 31	Stop Scan	140-164	CFD 6,4,2	O.K.	
2004 09 27	Start Scan	160-199	CFD 10,8,12	O.K.	
2004 09 27	Stop Scan	140-164	CFD 6,4,2	O.K.	

1) Data obtained in Lab, on LENA “Start” FLIGHT MCP’s

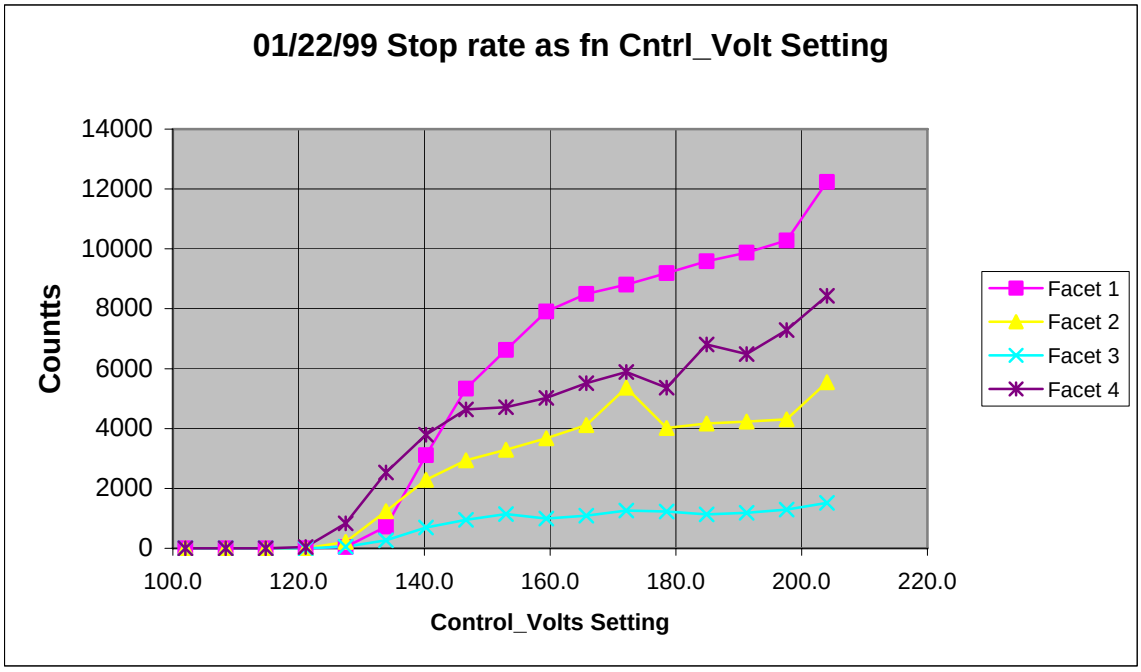
All readings were taken with Constant Fraction Discriminator (CFD Thresholds) setting set to “10”. Note CFD settings range from 0 (High) to 15 (Lowest).



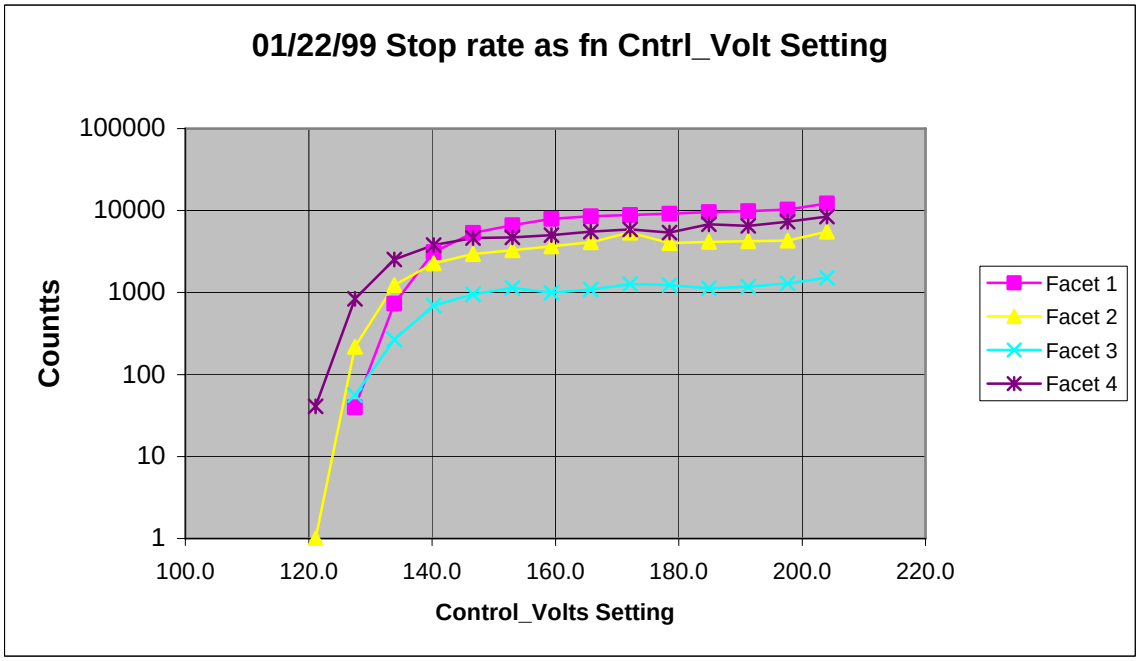
2) As above, Y axis Log plot.



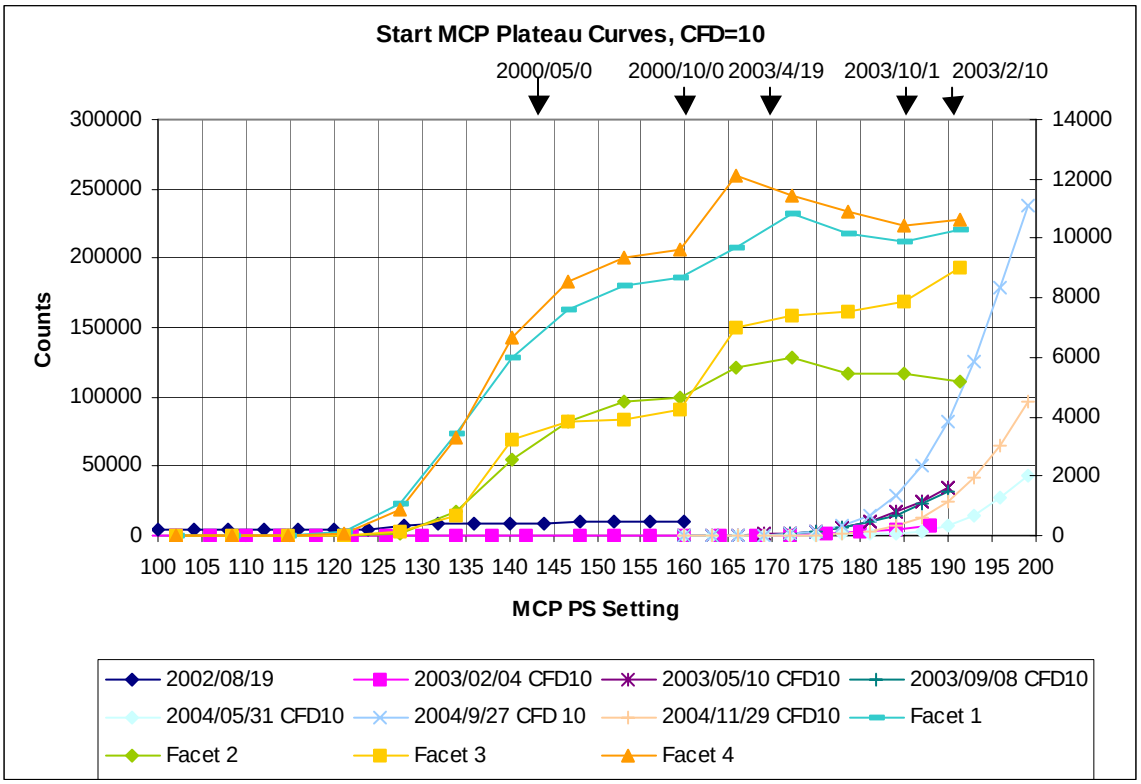
3) Data obtained in Lab, on LENA “Stop” FLIGHT MCP’s



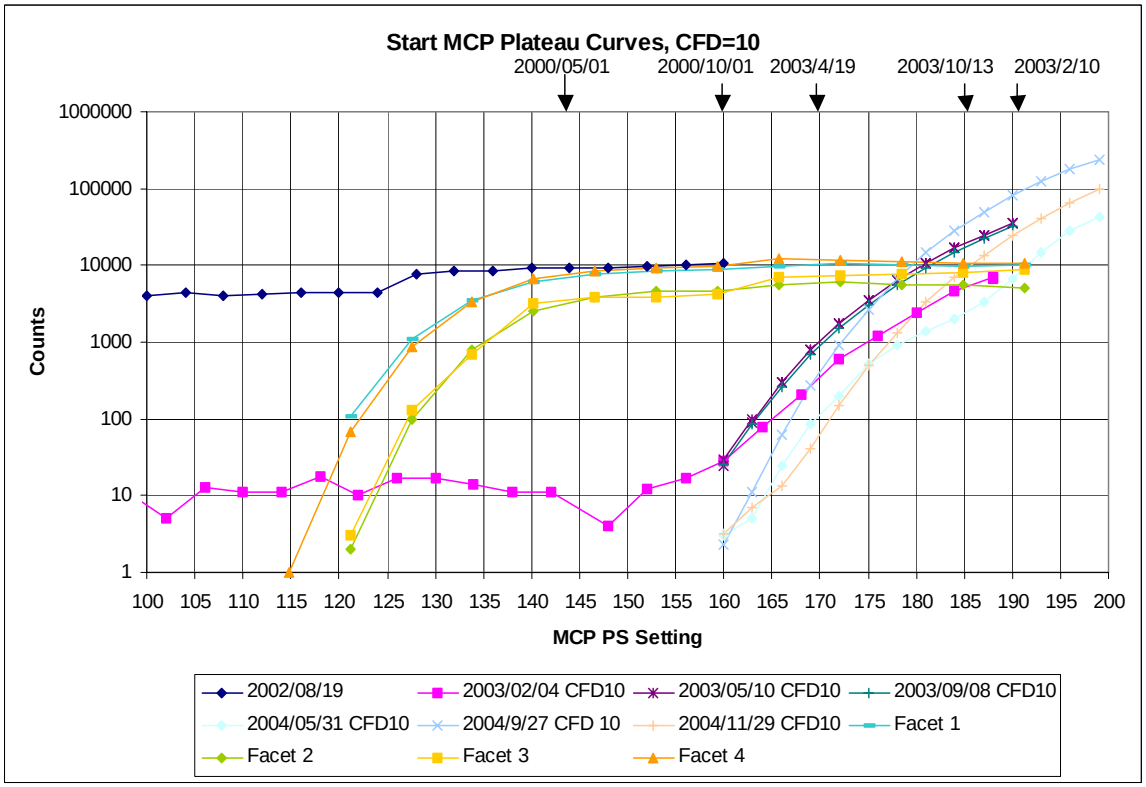
4) As above, Y axis Log plot.



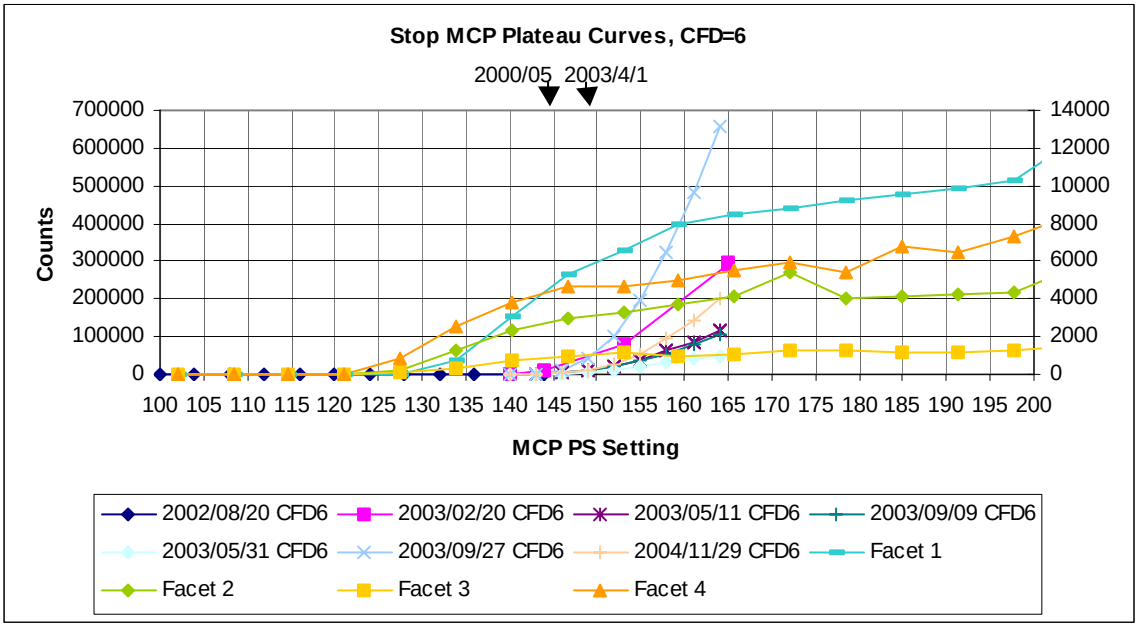
Data obtained for the start MCP's over 6 yrs. The first systematic flight plateau curves were obtained in 2003. Operating points indicated by arrows.



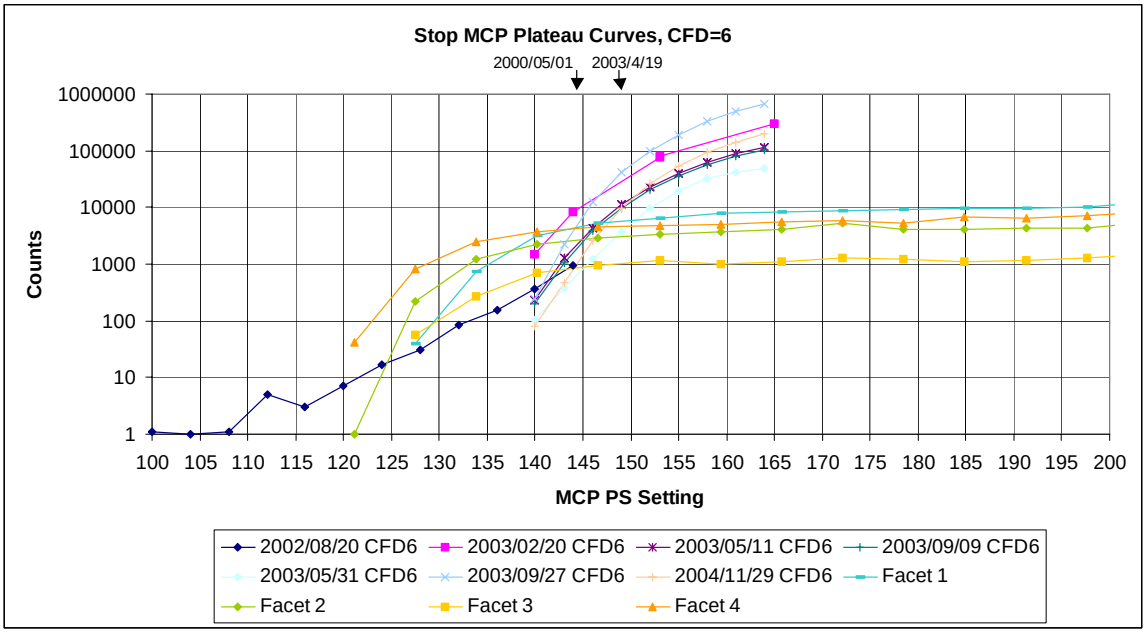
As above, log plot



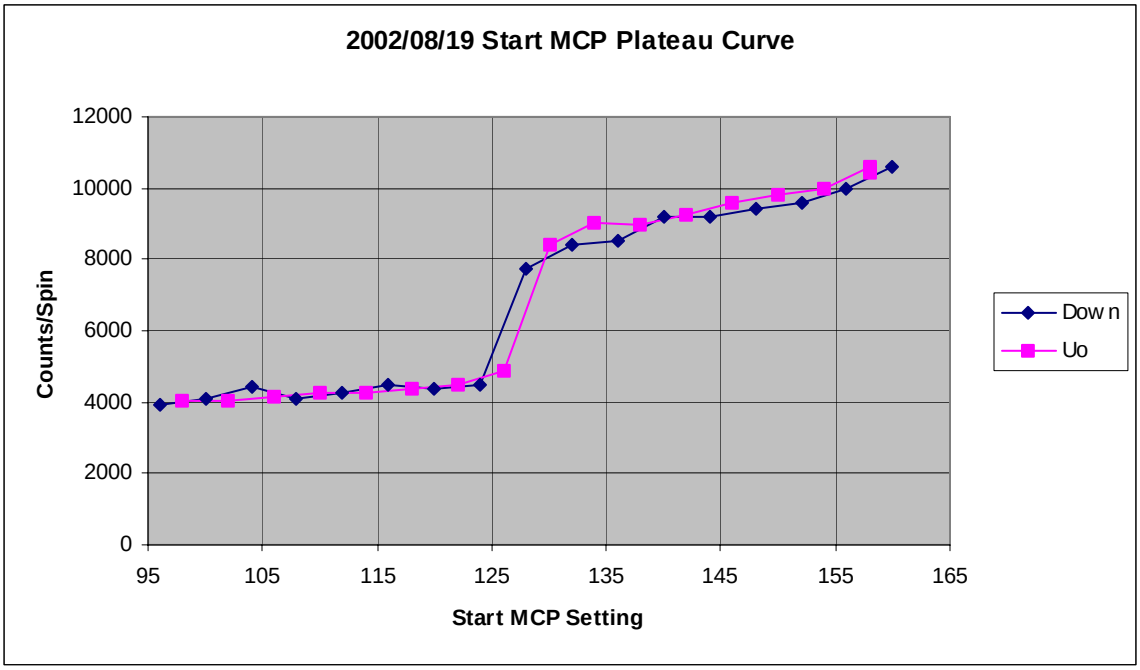
Data obtained for the stop MCP's over 6 yrs. The first systematic flight plateau curves were obtained in 2003. Operating points indicated by arrows.



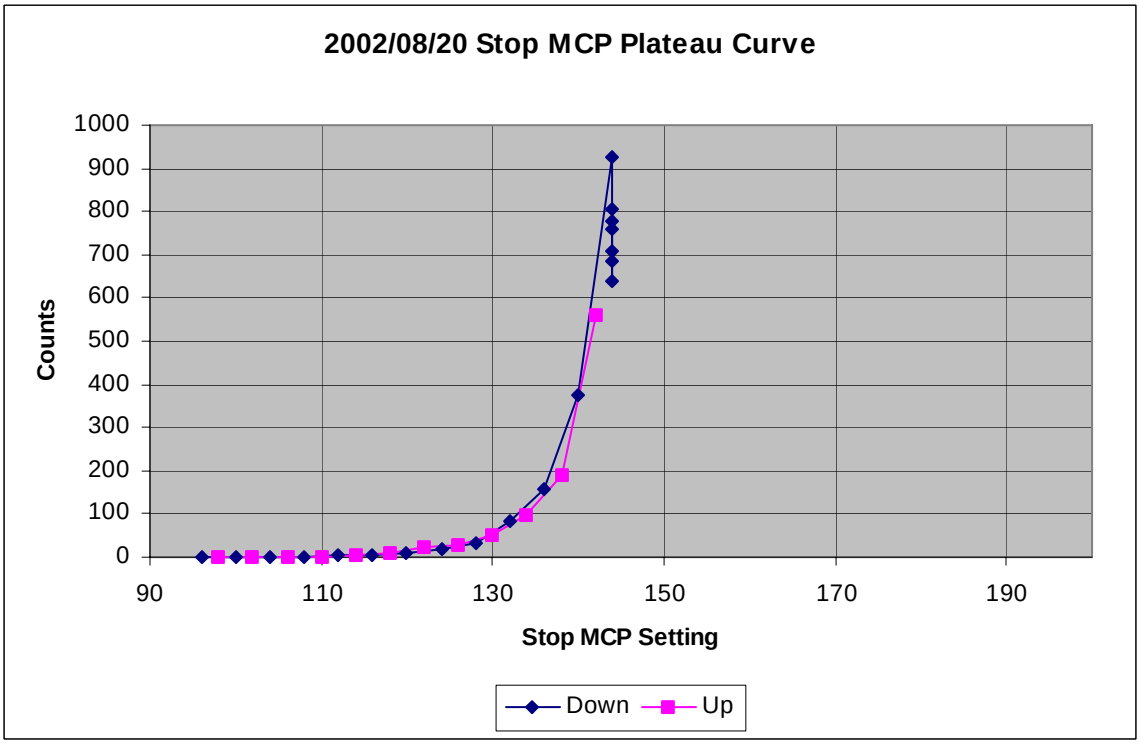
As above, log plot



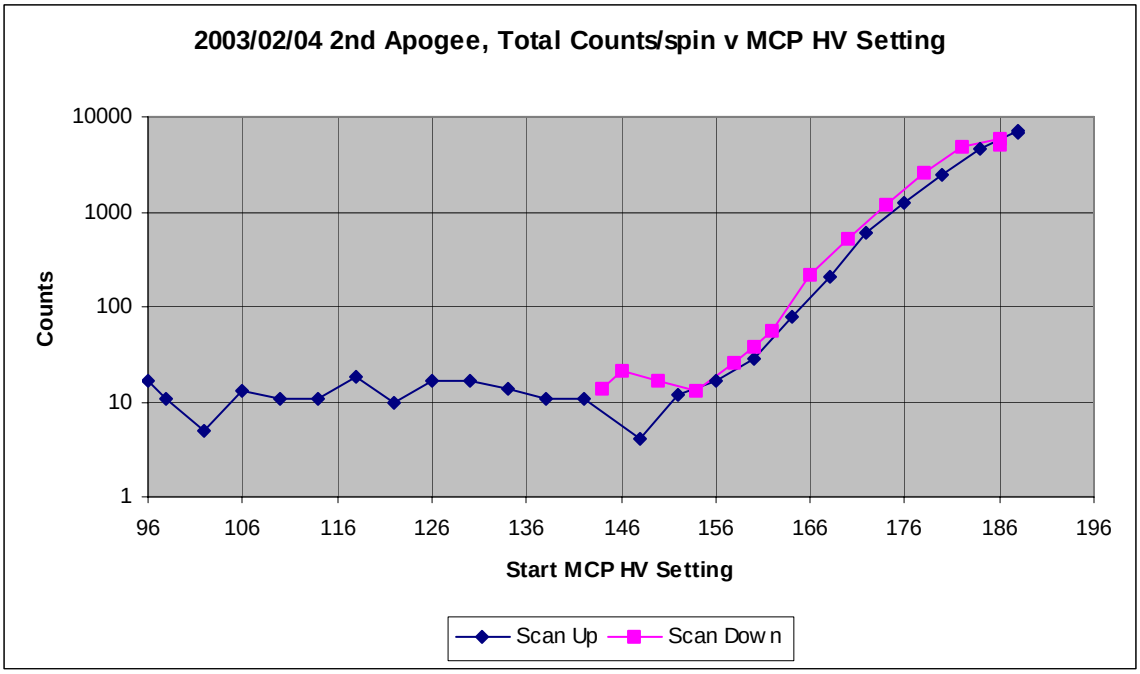
2002/08/19 Start Scan, Default Starts = 160, Stops = 144



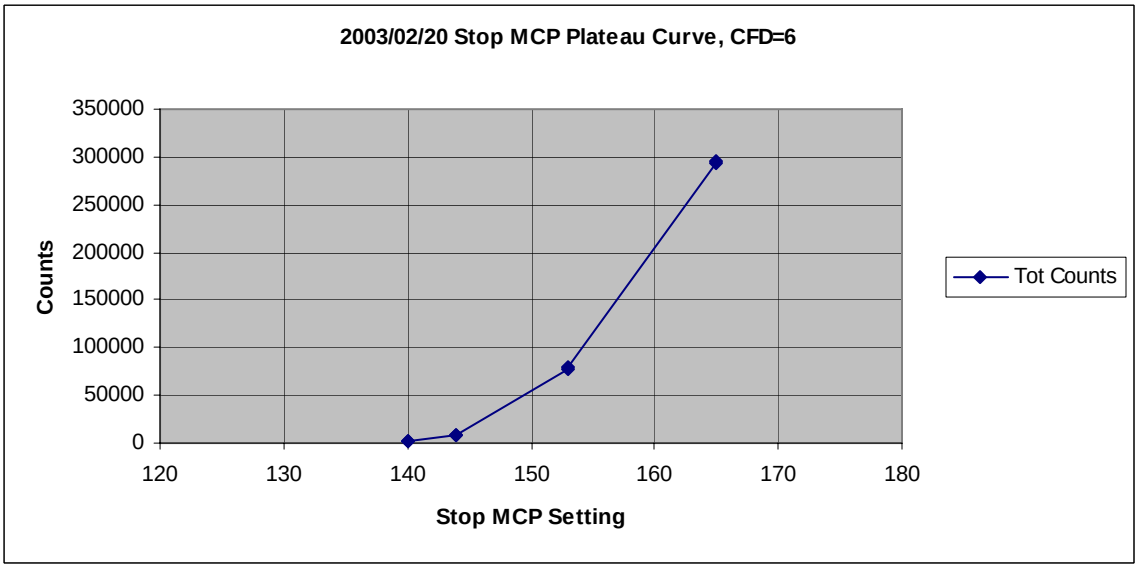
2002/08/20 Stop Scan, Default Starts = 160, Stops = 144



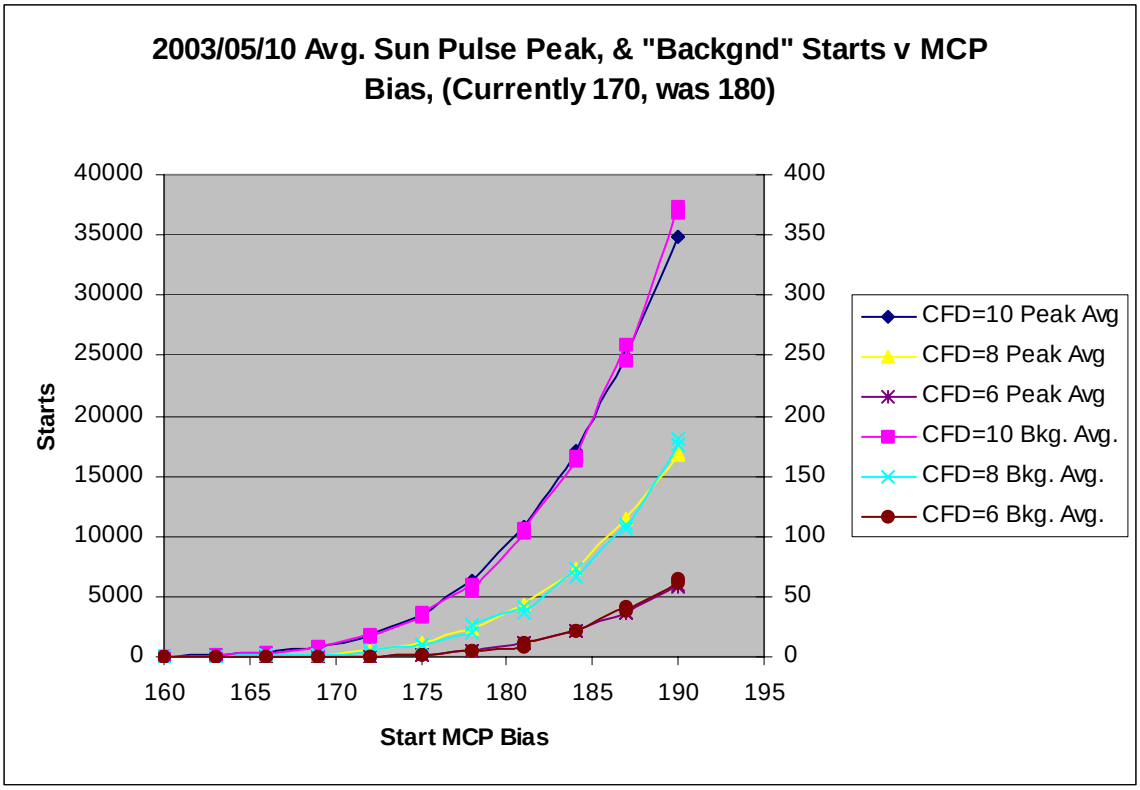
2003/02/04 Start Scan, Default Starts = 160, Stops = 144



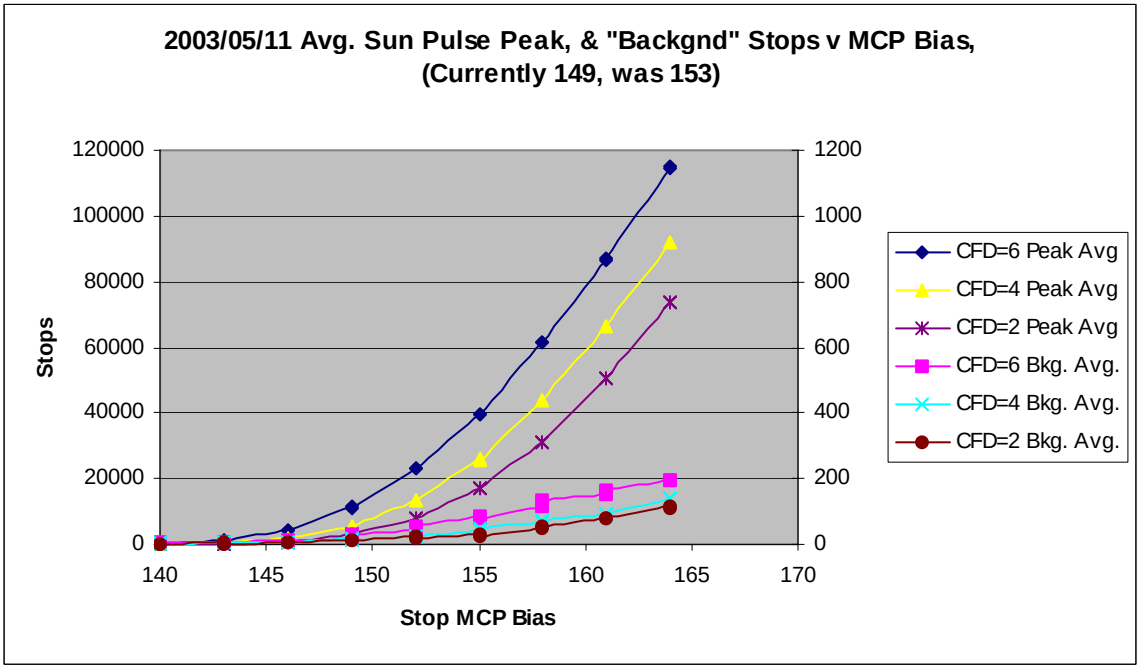
2003/02/20 Stop Scan, Default Starts = 160, Stops = 144



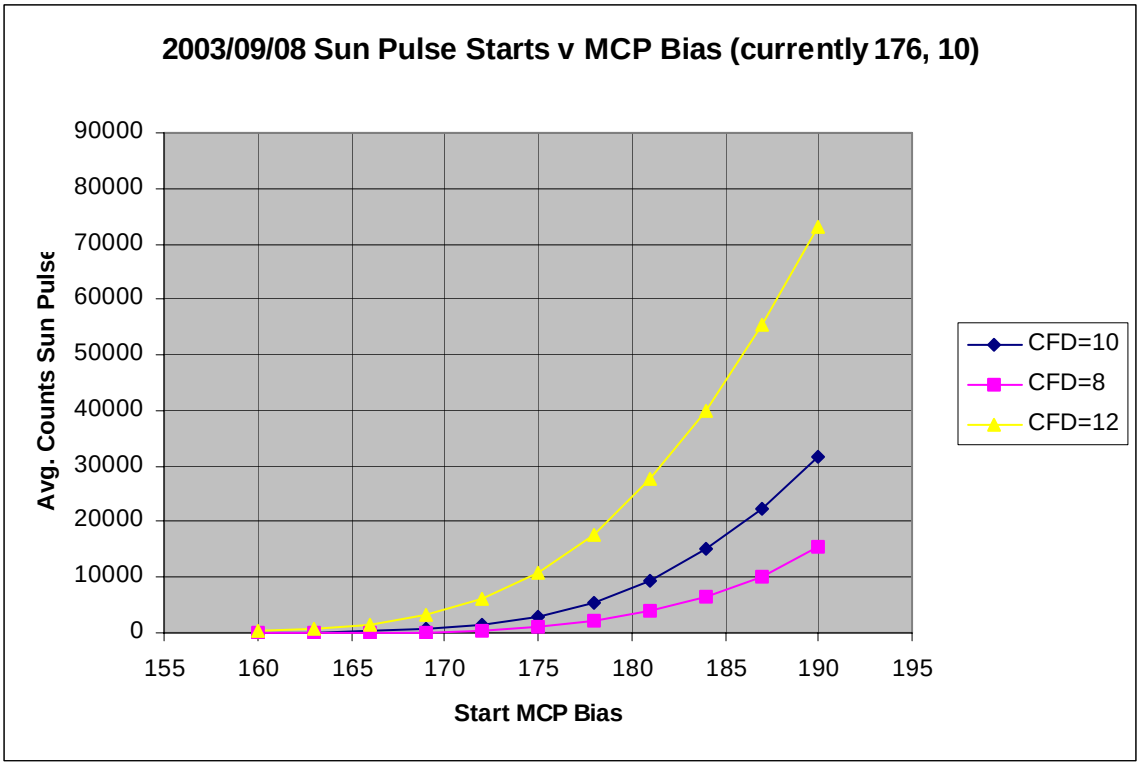
2003/05/10 Start Scan, 3 CFD settings



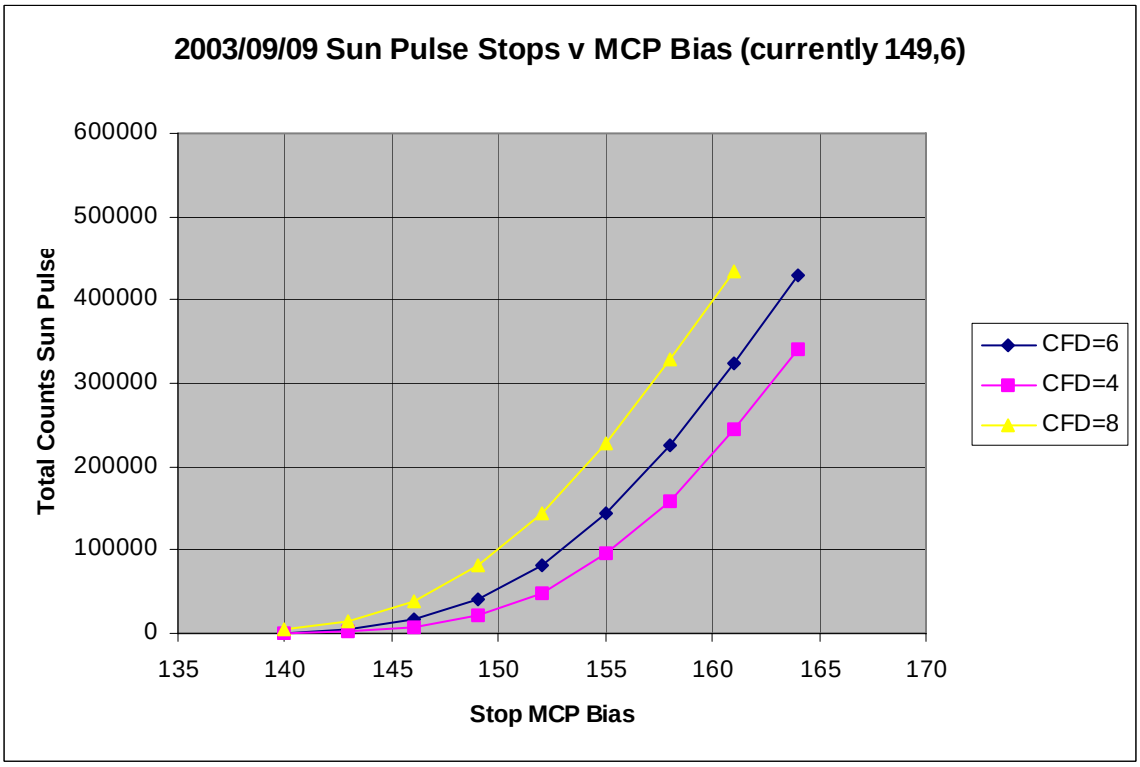
2003/05/11 Stop Scan, 3 CFD Settings



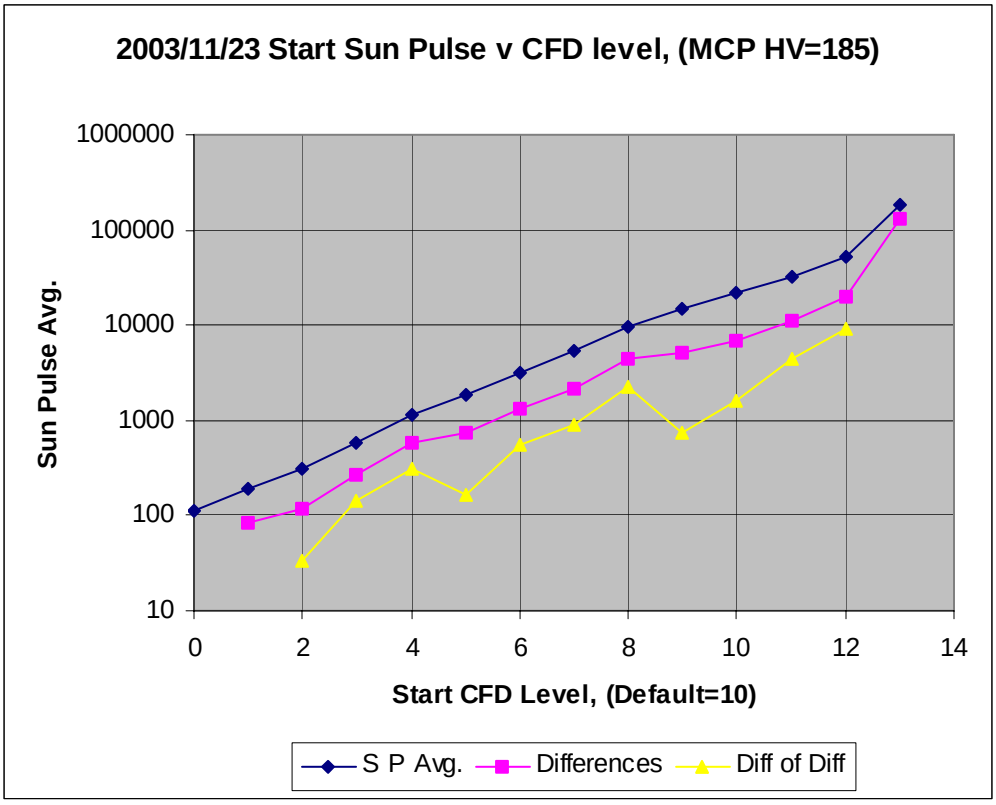
2003/09/08 Start Scan



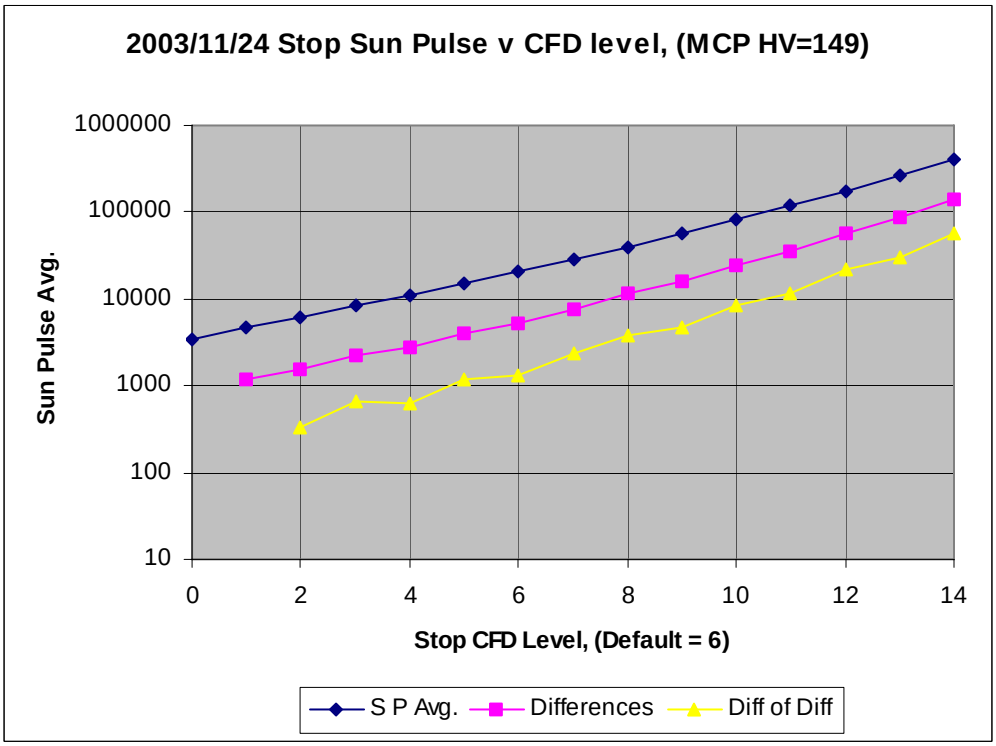
2003/09/09 Stop Scan



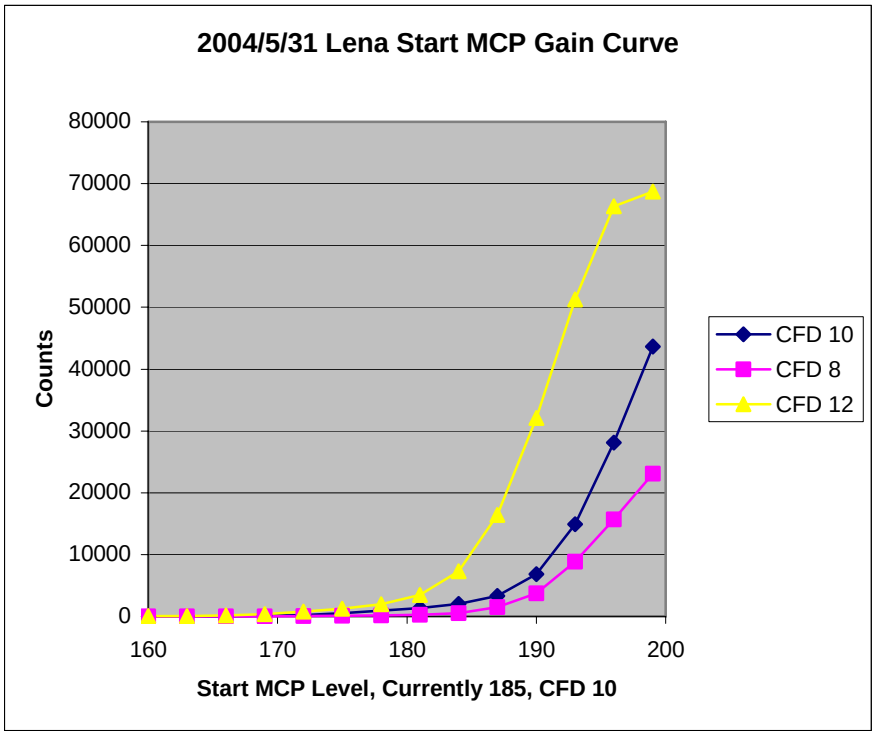
2003/11/23 Starts V CFD level



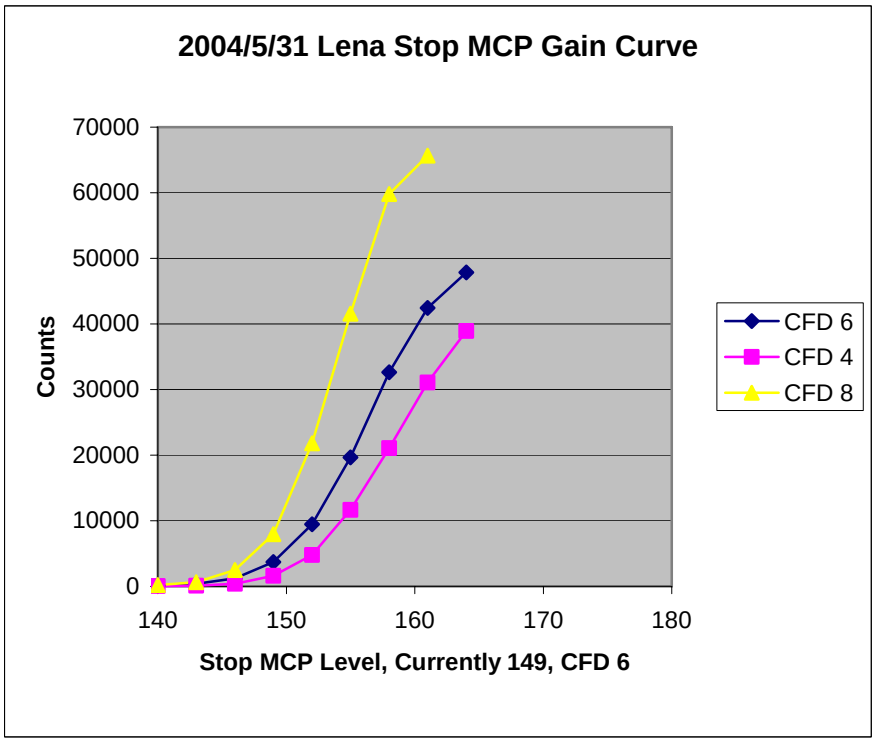
2003/11/24 Stops V CFD level



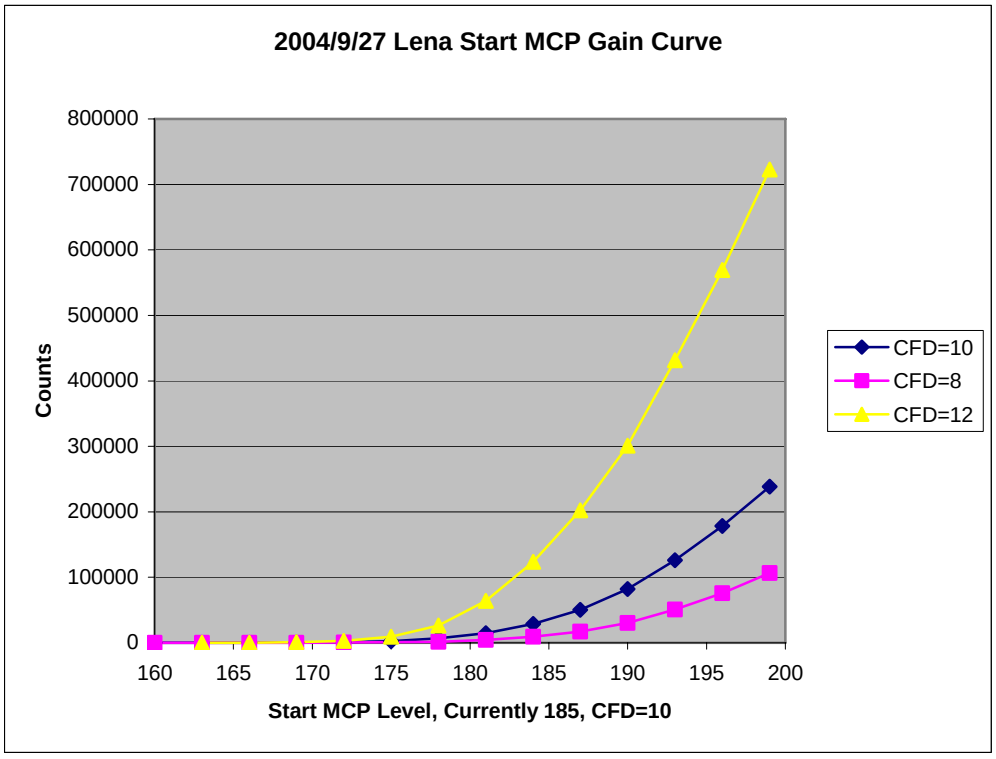
2004/5/31 Start Scan



2004/5/31 Stop Scan



2004/9/27



2004/9/27